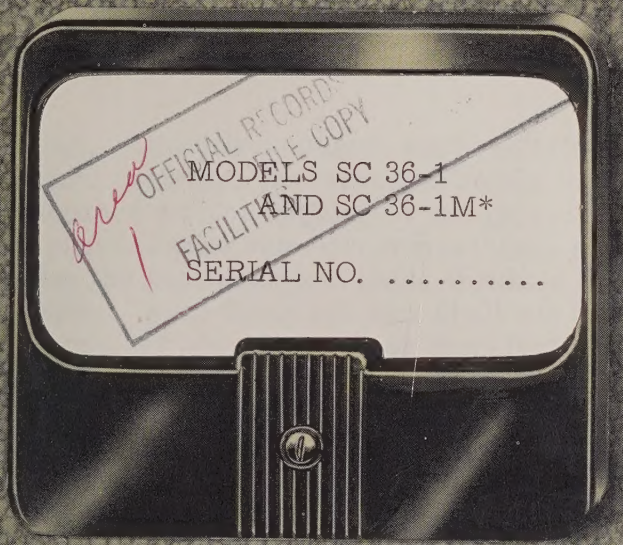
Kepco

INSTRUCTION MANUAL



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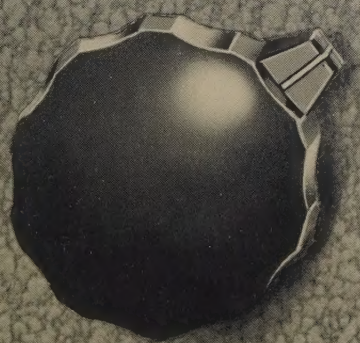
* VOLTAGE REGULATED POWER SUPPLIES



Kepco Inc.

INSTRUCTION MANUAL:

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MODELS SC 36-1
AND SC 36-1M*

SERIAL NO. .....

KEPCO, INC.
131 - 38 Sanford Avenue
Flushing 52, New York

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SECTION A

ELECTRICAL AND PHYSICAL SPECIFICATIONS

.....AC INPUT:

105-125 volts, 50-65 CPS single phase, 1.2 amperes (maximum), 113 watts (maximum).

.....DC OUTPUT VOLTAGE:

0-36 volts continuously variable.

.....DC OUTPUT CURRENT:

0-1 ampere continuous duty.

.....REGULATION:

Load Regulation: 0.1% or 0.003 volt, whichever is greater, for load variation from 0 to 1 ampere.

Line Regulation: Less than 0.1% for line fluctuation from 105-125 volts.

.....RIPPLE VOLTAGE:

Less than 1 millivolt RMS under all conditions.

.....STABILITY:

Approximately 3/4 of an hour is required for this power supply to reach equilibrium from a "cold start". The drift during the warm-up time is less than 1/2%.

The output voltage variation is less than 0.1% or 0.006 volt, whichever is greater, for a period of 8 hours after reaching equilibrium.

.....TEMPERATURE COEFFICIENT:

Output voltage changes less than 0.05% per °C.

.....OUTPUT IMPEDANCE:

Less than 0.04 ohm from DC to 1 KC.

Less than 0.4 ohm from 1 KC to 100 KC.

.....RECOVERY TIME:

50 Microseconds.

.....AMBIENT OPERATING TEMPERATURE:

-20°C to 50°C.

.....STORAGE TEMPERATURE:

-40°C to +95°C.

.....INPUT AND OUTPUT TERMINATIONS:

DC terminals are clearly marked on the front panel. All terminals are isolated from the chassis. Either positive or negative terminal of the DC output may be grounded. A terminal is provided for connecting to the chassis. The DC terminals are also brought out to a barrier terminal board at the rear of the unit.

.....REMOTE OUTPUT VOLTAGE CONTROL: (OHMS/VOLT)

Two terminals on the rear terminal board are provided for remotely controlling the output voltage. FOR EACH 1,000 OHMS CHANGE IN REMOTE CONTROL RESISTANCE THE OUTPUT VOLTAGE CHANGES ONE VOLT.

.....REMOTE ERROR SIGNAL SENSING:

Two terminals on the rear terminal board are provided for remotely sensing the error signal directly at the load. This connection compensates for the voltage drop in the wires connecting the power supply to the load.

.....PROTECTIVE FEATURES:

Current Limit Adjust - Can be set from 0 to 120% of full load. Current is limited to pre-set value for any load including short circuit.

Over-Temperature Control - A pre-set temperature sensitive device will automatically turn off the equipment if the temperature of the pass transistors becomes excessive. To turn the power supply on again, once an over-temperature condition has occurred, remove the external load from the power supply and wait approximately 3 to 5 minutes for the unit to cool. After this interval turn the power switch OFF and then ON again. If the power goes off the unit has not cooled to a safe operating temperature.

Fuse Protection - Input fuse on front panel.

.....CONTROLS:

Power on-off switch; one turn voltage control on front panel.

.....*METERS:

Voltmeter: 0-50 volts, 2-1/2".

Ammeter: 0-1 ampere, 2-1/2".

.....DIMENSIONS:

Height 4-1/4", width 8-5/32", depth 13-5/8". This unit is designed for bench use and is enclosed in its own cabinet. Rack panel adapters are available for mounting either one or two of these units in a standard panel 19" wide, 5-1/4" high.

.....COLOR:

Kepco Standard Dark Gray Hammertone.

SECTION B.

THEORY OF OPERATION

This power supply is of a servo or closed loop design in which the pass elements are in series with the load. (See block diagram B-1).

The voltage drops in the closed loop system are automatically adjusted according to the comparison of a sample output voltage with the reference voltage in the CONTROL UNIT. The differential product of this comparison is amplified and fed back as the ERROR INPUT to control the voltage drop across the pass transistors. The ERROR INPUT to the PASS CIRCUITRY is a negative or degenerative feedback signal. Consequently, the voltage drop across the pass transistors is such as to oppose output voltage change.

CAPITALIZED TERMS ADOPTED FOR FOLLOWING OUTLINE AND DISCUSSION REFER TO DESIGNATIONS ON THE CIRCUIT SCHEMATICS IN THE REFERENCE INDEX.

.....1. POWER UNIT (Circuit Schematic Tile)

A. INPUT CONTROL CIRCUITRY - Controls power input from the line to the DC SOURCES.

B. DC SOURCES - Provide main and auxiliary rectified power for all DC circuitry.

C. PASS CIRCUITRY - In the MAIN DC path to the output. All current drawn by the load goes through the pass elements, hence the name.

.....II. CONTROL UNIT (Circuit Schematic Tile)

A. REFERENCE VOLTAGE CIRCUITRY - Maintains a stable voltage standard for the comparison circuitry.

B. THE COMPARISON AMPLIFIER - Functions as the "error sensing" and cascade amplification circuit.

.....III. COMPARISON BRIDGE -

Consists of elements in both the POWER UNIT and CONTROL UNIT in a circuit configuration which effects a comparison between an output voltage sample and a stable reference voltage.

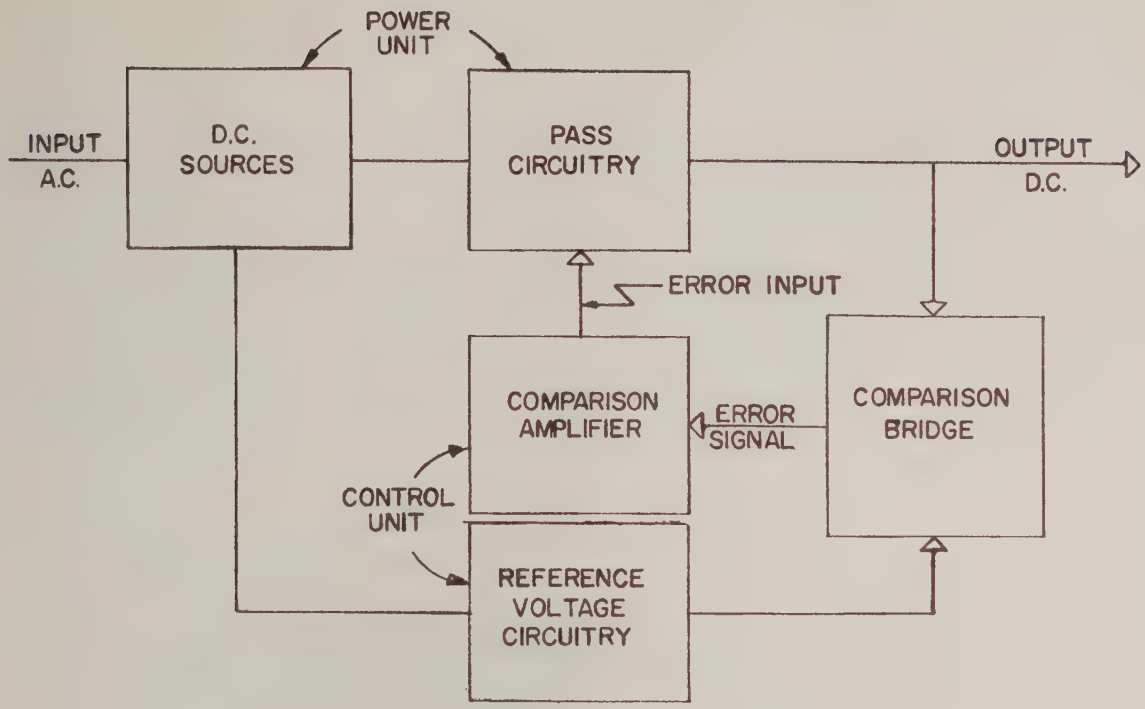


DIAGRAM B-1

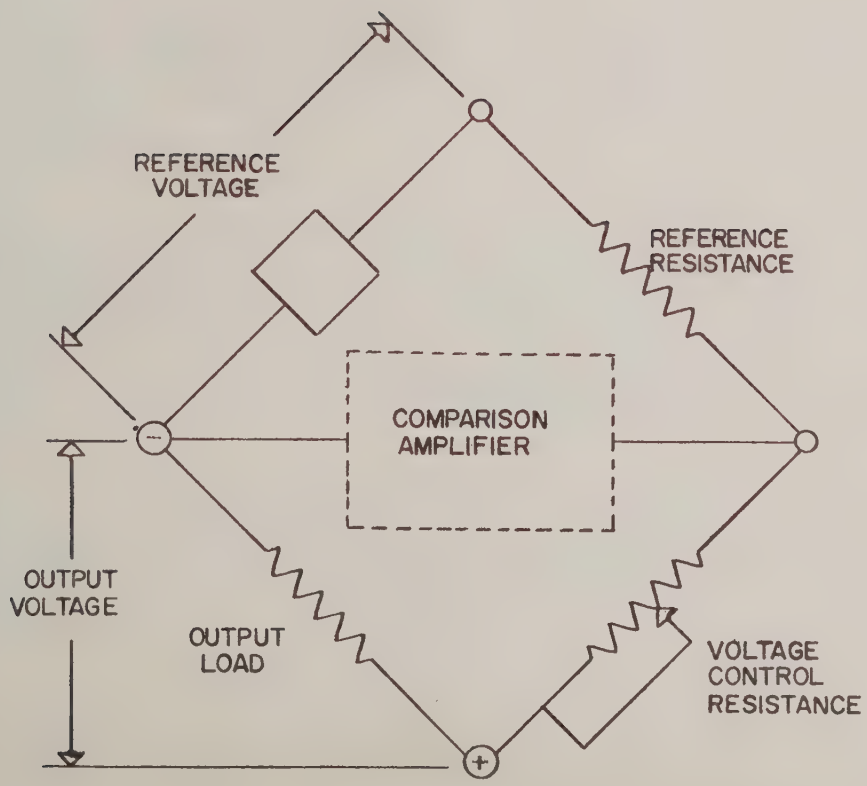


DIAGRAM B-2

NOTE:

The following discussion describes the elements of the foregoing outline in greater detail. As before, capitalized terms refer to designations on the schematic diagrams. Some of this discussion is of a general nature and may not apply in every detail to this specific model. Variations in the basic outline occur primarily in connection with the PASS CIRCUITRY INPUT CONTROL CIRCUITRY or the REFERENCE VOLTAGE CIRCUITRY and reflect design considerations relevant to the particular output requirements of the model. It should not be assumed that a set of circuit schematics is incomplete because it does not include all of the reference nomenclature used in this discussion.

I. POWER UNIT

A. INPUT CONTROL CIRCUIT:

(1) With the input switch closed, a forward bias on one semiconductor diode in the ENERGIZING CIRCUIT will draw a charging current for the capacitor which energizes the INPUT RELAY coil closing the input to the DC SOURCES transformers. As soon as the INPUT RELAY is closed, the DC in the input control circuit circulates through the thermal relay and input relay coil, bypassing the charged capacitor and holding the relay closed.

(2) If the pass element containing the thermostat control becomes overheated, the thermal switch opens the DC path to the INPUT RELAY de-energizing the relay coil and cutting off the input to the DC SOURCES.

NOTE:

The AC line power must be interrupted in order to reset the input relay after the thermal switch has opened the input to the DC SOURCES. Once the capacitor in the ENERGIZING CIRCUIT is charged, it cannot hold the relay when the thermal switch opens. This action tends to prevent damage to the pass elements from overheating in case the transistor associated with the thermostat dissipates heat faster than the other pass elements.

(3) When the input relay is opened by the action of the thermal switch or by pulling the line cord, the DISCHARGE RESISTOR effectively shorts the MAIN FILTER CAPACITOR preventing overvoltage surges.

B. DC SOURCES:

(1) RETURN SUPPLY (full wave rectified and filtered) - provides a return path for leakage current (I_{CO}) from the pass transistors.

It is also a bleed path which provides a minimum operating current for the emitters of the pass transistors, enabling them to continue to remain operative or "sensitive" to the ERROR INPUT when the load current becomes zero or vanishingly small.

(2) MAIN SUPPLY (full wave rectified and filtered) - provides MAIN DC for the output, subject to the regulatory action of the PASS CIRCUITRY. The MAIN DC path includes the pass elements and the load in series.

(3) I_{CO} SUPPLY (full wave rectified) - Provides a supply of current to prevent spurious biasing of the pass transistors by collector leakage current (I_{CO}). I_{CO} generated as a function of temperature and flowing oppositely to the emitter base current tends to alter the ERROR INPUT unless this compensating supply provides bias stabilization.

(4) COLLECTOR SUPPLIES (negative half-cycle rectified) - provide proper collector bias for the PRE-DRIVERS.

C. PASS CIRCUITRY:

The power transistors which function as pass elements may be regarded as electronic variable resistors (or variable conductors) controlled or "varied" by an amplified ERROR INPUT. The amount of current "passed" by these transistors is a function of the magnitude of the forward conducting emitter-base bias. Since the ERROR INPUT is applied to the base terminal, a negative input will aid the forward conducting bias of a PNP transistor while a positive input will reduce the forward conducting bias. In response to the polarity and magnitude of the ERROR INPUT, the pass transistors control the current and voltage distribution in the MAIN DC loop and effect a constant output voltage.

Two main classifications of pass transistors may be indicated on the schematic acoording to the way in which they are driven:

(1) DRIVEN PASS - "driven" by the ERROR INPUT from the CONTROL UNIT. A DRIVER and a PRE-DRIVER may be connected in cascade with the DRIVEN PASS. These amplification stages increase the response and sensitivity of the system to cutput voltage changes. The DRIVEN PASS may be a single series pass transistor

or a series pass group of transistors connected in parallel for increased current capacity.

(2) SLAVE PASS - found in transistorized units requiring more than one series pass group in the MAIN DC path. These pass transistors "slavishly" follow the response of the DRIVEN PASS to the ERROR INPUT. The SLAVE PASSES are driven through a SLAVE VOLTAGE DIVIDER which effects an approximately equal voltage division among the series pass groups in models where the voltage range requires more than one group of series pass elements. The SLAVE PASSES may or may not have preliminary amplification stages in cascade.

When series pass groups contain transistors connected in parallel, an EQUALIZING RESISTOR is associated with each transistor. These EQUALIZING RESISTORS, tied to each emitter, provide a means of compensation for intrinsic differences among transistors within a pass group.

The expression "drop voltage" is sometimes used to describe the amount of voltage drop required of the pass elements to bring the COMPARISON BRIDGE into balance. This is the difference between the input and the desired output. True balance or stability is inherently impossible in a servo system, but the unbalance may be reduced to as small a magnitude as desired in a dynamically corrective system.

II. CONTROL UNIT

A. REFERENCE VOLTAGE CIRCUITRY:

The function of the REFERENCE VOLTAGE CIRCUITRY is to maintain a precise, stable voltage for the COMPARISON BRIDGE. This is normally achieved according to the model CONTROL UNIT with either of two basic design approaches:

(1) A CASCADE ZENER REFERENCE, consisting of Zener diodes of succesively decreasing values in cascaded stages each of which produce an increasingly regulated reference voltage. In practice, usually only two stages are used so that in effect the first Zener diode is a regulator for a voltage reference diode.

(2) Balanced amplifier regulation - Any disparity between the bases of the transistors in the set of 1st BALANCED AMPLIFIERS is coupled to the set of 2nd BALANCED AMPLIFIERS. The 2nd BALANCED AMPLIFIERS couple this amplified "error signal" to a REFERENCE DRIVER and a REFERENCE PASS which regulate the current through a REFERENCE DIODE in a manner analogous to the action of the PASS CIRCUITRY in the POWER UNIT.

B. COMPARISON AMPLIFIER CIRCUITRY:

(1) The COMPARISON AMPLIFIER consists of a series of cascaded transistor amplifiers which boost the "error input" to a sufficient level to drive the PASS CIRCUITRY in the POWER UNIT.

(2) The COMPARISON AMPLIFIER is connected across the COMPARISON BRIDGE from the junction of the VOLTAGE CONTROL and the REFERENCE RESISTANCE to the junction of the Zener reference diode and the negative output terminal. (See Diagram B-2). This arrangement is similar to that of the null galvanometer across a Wheatstone bridge. The unbalance in the COMPARISON BRIDGE is detected and amplified by the COMPARISON AMPLIFIER CIRCUITRY beginning a chain of circuit responses which produce an ERROR INPUT signal of proper phase and magnitude to effect corrective action by the pass circuitry.

.....III. Comparison Bridge:

(1) This bridge circuit implements the comparison between the OUTPUT VOLTAGE and the REFERENCE VOLTAGE. The signal produced by the comparison drives the COMPARISON AMPLIFIER CIRCUITRY.

(2) The Comparison Bridge is represented schematically in Diagram B-2.

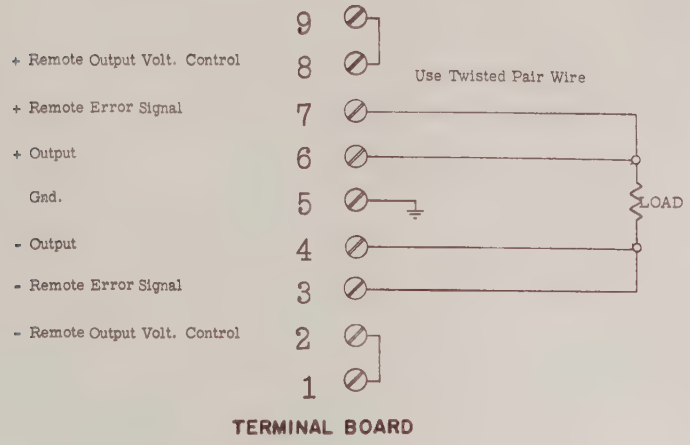
(3) Balance occurs in the Comparison Bridge when the following ratios are equal:

$$\frac{\text{Output Voltage}}{\text{Voltage Control Resistance}} = \frac{\text{Reference Voltage}}{\text{Reference Resistance}}$$

(4) When the Comparison Bridge is unbalanced by a decreasing output voltage drop across the load, it gives rise to a negative bias at the base of the COMPARISON FOLLOWER in the COMPARISON AMPLIFIER CIRCUITRY. This signal, amplified, acting as the ERROR INPUT negatively biases the base of the DRIVEN PASS, aiding its forward conducting bias and increasing the output voltage.

(5) A bridge unbalance caused by an increasing output voltage produces, of course, a chain of oppositely biased circuit responses which reduce the voltage across the load.

CONVERTING TO REMOTE ERROR SENSING



PROCEDURE:

1. With AC input disconnected, remove jumper between POSITIVE OUTPUT and POSITIVE REMOTE ERROR SIGNAL (terminals 6 and 7) between NEGATIVE OUTPUT and NEGATIVE REMOTE ERROR SIGNAL (terminals 4 and 3) on rear terminal strip.

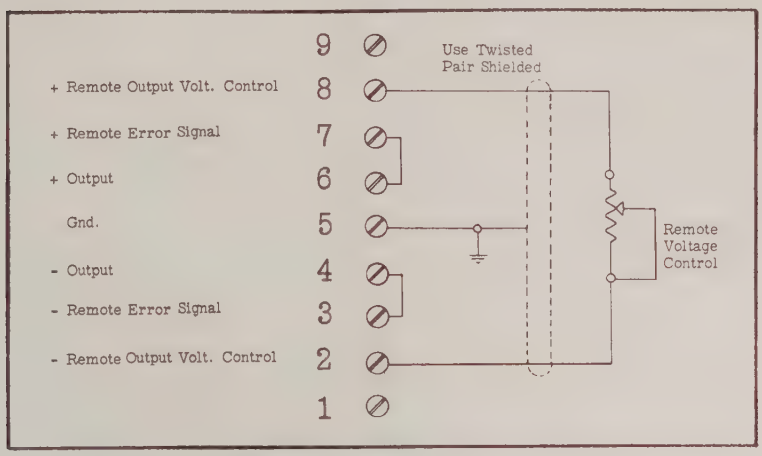
2. Using twisted pair wire, connect sensing leads from POSITIVE REMOTE ERROR SIGNAL (terminal 7) and from NEGATIVE REMOTE SIGNAL (terminal 3) to the load, observing polarities.

3. Using twisted pair wire, connect load supply leads from POSITIVE OUTPUT (terminal 6) and NEGATIVE OUTPUT (terminal 4) to the load.

NOTE: In operations requiring remote error sensing, voltage drops across the load supply leads will change the effective setting of the maximum current adjustment and possibly worsen regulation. By setting the MAXIMUM CURRENT ADJUST on the CONTROL UNIT it is possible to compensate for this effect for up to a maximum drop of 1/2 volt across the negative load supply lead. The 1/2 volt limit is imposed by the fact that this drop reduces the maximum forward conducting bias on the series pass transistors. The input base bias to the pass transistor is limited by the factory setting of the MAXIMUM CURRENT ADJUST. Consequently to avoid a deterioration in the ability of the pass transistors to follow the ERROR SIGNAL feedback and correct the output voltage, the following steps should be taken:

1. Turn CURRENT LIMIT ADJUST (if provided) to maximum clockwise position.
2. Load the power supply with the remote resistance necessary to draw slightly more than 120% of the maximum rated supply current at the indicated supply output voltage.
3. Turn MAXIMUM CURRENT ADJUST clockwise until output current reaches 120% of maximum rating.

CONVERTING TO REMOTE OUTPUT VOLTAGE CONTROL



TERMINAL BOARD

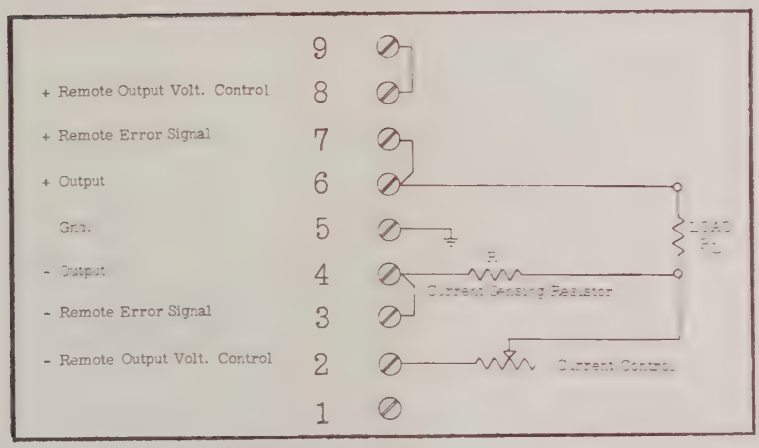
PROCEDURE:

1. The REMOTE VOLTAGE CONTROL resistance, fixed or variable, should be equal to the product of the desired output voltage and the ohms per volt ratio specified for this model. (See discussion on REMOTE OUTPUT VOLTAGE CONTROL terminals in Section A).

2. With AC power disconnected, remove jumper between POSITIVE REMOTE OUTPUT VOLTAGE CONTROL (terminal 8) and terminal 9, and jumper between NEGATIVE REMOTE OUTPUT VOLTAGE CONTROL (terminal 2) and terminal 1.

3. Connect shielded twisted pair wire leads from POSITIVE REMOTE OUTPUT VOLTAGE CONTROL (terminal 8), and from NEGATIVE REMOTE OUTPUT VOLTAGE CONTROL (terminal 2) to REMOTE VOLTAGE CONTROL resistance. REMOTE VOLTAGE CONTROL, if variable, should be connected so that clockwise rotation increases resistance.

CONVERTING TO CURRENT REGULATED OPERATION



TERMINAL BOARD

PROCEDURE:

1. Remove jumper between NEGATIVE REMOTE OUTPUT VOLTAGE CONTROL (terminal 2) and terminal 1.

2. Connect a CURRENT CONTROL resistor from the NEGATIVE REMOTE OUTPUT VOLTAGE CONTROL (terminal 2) to the load as shown in the above diagram. The CURRENT CONTROL resistance should be numerically equal to (in ohms) or greater than the ohms/volt ratio specified for this unit in the discussion on REMOTE OUTPUT VOLTAGE CONTROL terminals in Section A. (e.g. for a 330 ohms/volt model use a 500 ohm pot.).

3. Choose a CURRENT SENSING resistance sufficient to produce a 1 volt drop at maximum desired output current. Connect this CURRENT SENSING resistor in series with the external load R_L and the NEGATIVE OUTPUT (terminal 4).

   Current Sensing Res. = 1 / max. output amps. desired

SECTION D

MAINTENANCE AND REPAIRS

GENERAL:

(1) In servicing this equipment it should be remembered that the essential regulating circuitry is a closed loop DC servo system. Careless servicing may affect the whole system. The same circuit sensitivity which enables a high degree of regulation to be obtained also increases the susceptibility of the circuit components to interrelated functional disorders when the equipment is abused. No component is an "island entire in itself". Consequently, exercise the greatest care in making repairs.

(2) Before any systematic trouble-shooting is attempted, it is advisable to establish by careful examination whether any malfunction is attributable to "simple" mechanical disorders: broken leads, loose plugs, etc. Obviously, many "simple" disorders may be symptomatic, that is, effects rather than causes of equipment malfunction.

(3) The components of this power supply have been tested and selected to provide long and trouble free operation. Under normal operating conditions, maintenance will consist merely in oiling the fan every six months. However, if component failure occurs the unit should be serviced by personnel who are thoroughly familiar with transistor circuitry. SERIOUS, COSTLY DAMAGE CAN RESULT FROM CARELESS PROBING.

(4) PARTS LOCATION: New, revised, Instruction Manuals include Parts Location Photos. These photos together with schematic diagrams should facilitate trouble-shooting and replacement.

(5) CONTROL UNITS: Control Units or "TRAMS" are of a semi-modular plug-in design. (However, it is necessary, according to the particular model, to remove bracket screws or stand-off screws before the CONTROL UNITS can be unplugged.)

.....PRECAUTIONS:

(1) CHECK ALL TRANSISTORS BEFORE REPLACING ANY. IF ASSOCIATED TRANSISTORS ARE DEFECTIVE, THE REPLACEMENT MAY BE IMMEDIATELY RUINED.

(2) IF MAJOR REPAIRS ARE NECESSARY, THE FACTORY IS PREPARED TO HANDLE THEM. UNDER NO CIRCUMSTANCES SHOULD THE UNIT BE RETURNED TO THE FACTORY WITHOUT PROPER AUTHORIZATION AND SHIPPING INSTRUCTIONS. IN ANY CORRESPONDENCE WITH THE FACTORY CONCERNING REPAIRS, THE MODEL AND SERIAL NUMBER OF THE UNIT MUST BE GIVEN TOGETHER WITH A DESCRIPTION OF THE TROUBLE ENCOUNTERED.

(3) Check all fuses before applying power after any repairs or replacements have been made.

(4) If it is found that the output voltage cannot be varied over its entire range by means of the voltage control adjustment, be careful not to short the supply as severe damage to the unit may result. In this regard, if it is detected that the output voltage does not decrease as the

voltage control is turned counter-clockwise, DO NOT CONTINUE TO TURN THE CONTROL.

(5) If it is necessary to solder transistor terminals, it is recommended that the leads be held with pliers between the transistor and the point to be soldered in order to shunt heat and reduce the possibility of damage to semi-conductor junctions. This applies as well to semi-conductor diodes.

.....CHECKING TRANSISTORS:

(1) Since a transistor is essentially a combination of semi-conductor diodes, a short in both directions between any two of its terminals is sufficient indication that the transistor is defective. Characteristically, the ratio of the forward to the reverse resistance across a transistor junction should be at least 100. In the majority of cases, the bi-directional short will occur between the collector and emitter terminals. Occasionally, a short will occur between the base and either of the other two terminals, but this condition is usually compounded with an emitter-collector short.

(2) HIGH POWER TRANSISTORS - If possible, a power transistor checker should be employed, but on a Go-No-Go basis an ohmmeter will prove adequate to detect defective components. USING THE RX1 SCALE OF THE OHMMETER, TEST FOR SHORT WITH ONE POLARITY; REVERSING POLARITIES, TEST FOR SHORT IN THE REVERSE DIRECTION. PASS TRANSISTOR groups containing elements in parallel may be checked collectively without removal from the circuit. This is done by connecting an ohmmeter directly across the collector emitter terminals

of the pass elements. If any one of the transistors in parallel is shorted, the group will, of course, be shorted and require individual checking.

NOTE: PASS TRANSISTORS are mounted in most models on the chassis in plug-in heat sinks called "STATS". In early models these STATS could be disconnected simply by pulling the STAT plug from its socket. In the newer models, for increased structural rigidity, the STATS are fastened by self-tapping hex-head screws which must be removed from the underside of the chassis.

(3) LOW POWER TRANSISTORS - Can be adequately tested using standard "packaged" transistor checkers (e.g. Baird-Atomic Beta-h_{11} Model KT-1, Barber Labs. Junction Transistor Checker Model #29). IMPORTANT: BE SURE THE PNP-NPN SELECTOR SWITCH IS IN THE CORRECT POSITION.

NOTE: Associated with each PASS TRANSISTOR connected in parallel within a pass group is a low-value resistor, called an "equalizing resistor", which operates to equalize current distribution among the pass elements. It should be ascertained whether or not a defective equalizing resistor is contributing to or has resulted from operational disorders. If one of these resistors "burns open" it effectively removes a pass transistor from the main circuit and increases the dissipation requirements of the remaining elements.

.....REGULATION:

(1) GENERAL - The regulation of this unit has been precisely measured and found to conform to specification. It must be emphasized that when the regulation specification is of a low order of magnitude great care must be exercised in proceeding to verify this measurement. Otherwise, inaccuracies may be introduced by the test. For example: a full load current drawn through an uncompensated internal resistance of 0.0002 ohm in a 32 volt-15 ampere, 0.01% regulated power supply operating at maximum voltage will produce a voltage drop equal to the % regulation specification. This amount of resistance might easily be introduced by improper setup connections for regulation measurement.

(2) DEFINITIONS -

Line Regulation is specified as the % change in output voltage as the line voltage is varied from minimum to maximum or vice versa, with the load held at a constant value.

Load Regulation is specified as the % change in output voltage as the load is varied from minimum to maximum or vice versa, with the line voltage held at a constant value.

(3) INSTRUMENTATION -

a) A differential voltmeter or Kepco Regulation Analyzer 901B can be used to measure regulation.

The output may also be monitored by a DC coupled oscilloscope provided a buck-out device is employed. The buck-out source should be of a better order of regulation than the

power supply being tested, and for maximum sensitivity the buck-out source should provide a voltage of magnitude comparable to the output setting of the supply being tested.

b) A Variac or line voltage adjuster (e.g. Kepco Model 920B) and an AC voltmeter (e.g. Weston or equivalent) can be used to control and measure the line voltage.

c) Variable Load Resistance.

(4) CONNECTIONS - A major source of inaccuracy in measuring regulation is uncompensated voltage drops due to improper connections. Regulation should be measured at the Remote Error Signal or Output Terminals on the terminal board with the load taken from either front or rear output terminals.

IT IS STRONGLY RECOMMENDED THAT CONNECTIONS FOR THE INSTRUMENTATION SET-UP FOR MEASURING REGULATION BE MADE BY LOOPING #14 BUSS AROUND the Remote Error Signal or Output terminal SCREWS ON THE TERMINAL BOARD (with jumpers in place). (See Diagram following this section.)

(5) CAUTION -

a) To prevent possible deterioration of regulation due to voltage drops across the internal buss connecting front and rear output terminals, avoid measuring regulation at the front terminals when the load is taken from the rear output.

b) When the load is remotely located with respect to the power supply or load current requirements are high, voltage drops

across output leads must be compensated for by converting to Remote Error Signal operation. (See Section C of this manual)

c) If the load is split between the front or rear output terminals, the load at the rear will receive the best regulation, the front output voltage being higher by the amount of voltage drop in the internal buss.

.....FACTORY RETURNS:

It is important that units returned to Kepco for repair be tagged with a brief description of the defects observed by the customer.

This will greatly facilitate the recording, handling and scheduling necessary to expedite servicing.

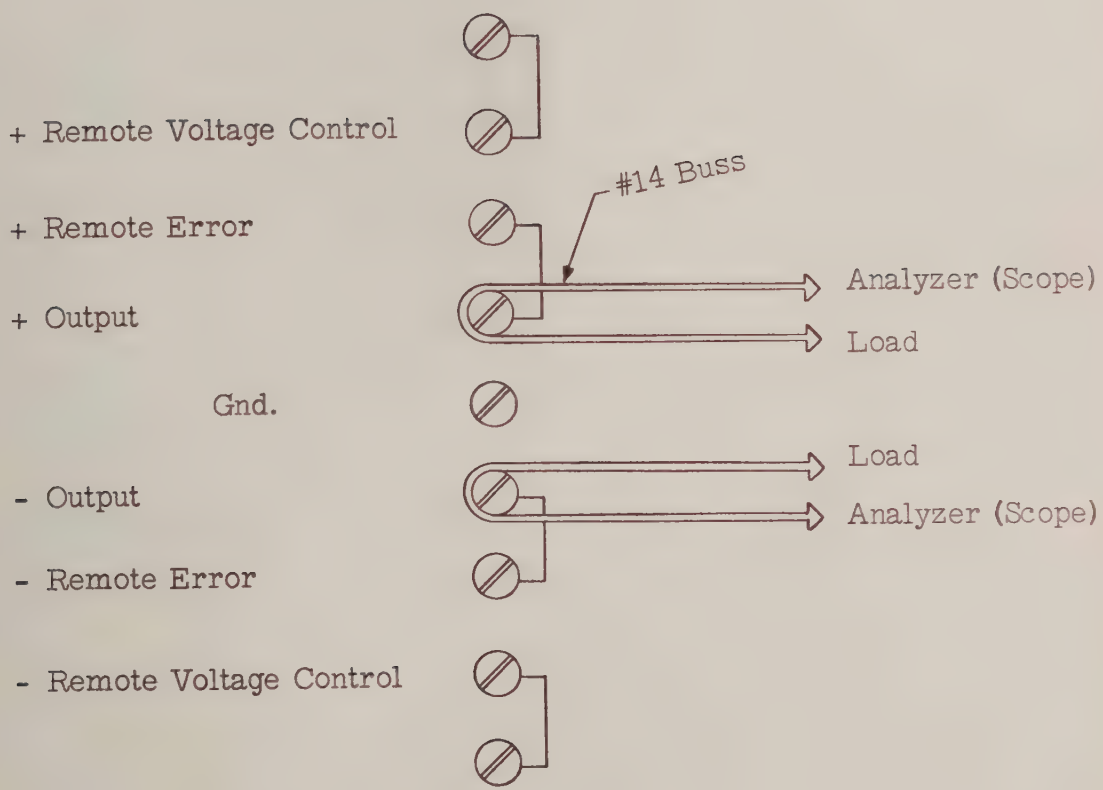
Under no circumstances should the unit be returned to the factory without proper authorization and shipping instructions. In any correspondence with the factory concerning repairs, the model and serial number of the unit must be given.

Cause numbers indicate order of probability

TROUBLE-SHOOTING CHART

SYMPTOM	CAUSE
A. NO OUTPUT	1. Overtemperature relay activated by: a. blocked ports b. ambient temperature too high c. defective fan d. defective relay 2. Input fuse blown by short in: rectifiers, transformer, main supply filter capacitor 3. Defective Control Unit (TRAM) 4. Defective ammeter
B. NO REGULATION HIGH OUTPUT VOLTAGE; VOLTAGE CONTROL DOES NOT DECREASE OUTPUT VOLTAGE (EXCEPT IN VARIAC UNITS).	1. Defective pass elements 2. Open Voltage Control Potentiometer 3. Defective Control Unit (TRAM) 4. Defective Driver or Pre-Driver associated with Pass Transistors
C. NO REGULATION LOW OUTPUT VOLTAGE	1. Current Limit Adjust set too low 2. Defective Control Unit (TRAM) 3. Incorrect conversion to remote error operation 4. Defective Main Filter capacitor

CONNECTIONS FOR REGULATION MEASUREMENT



SECTION E

CONTROL ADJUSTMENTS

.....OUTPUT VOLTAGE CONTROL:

The output voltage of this supply may be varied continuously through its specified range by means of an adjustable OUTPUT VOLTAGE CONTROL.

.....CURRENT LIMIT ADJUST: (Designated CL on schematics)

The maximum safe current capacity of this supply is 120% of the rated supply. An automatic current limiting device in the Control Unit limits the pass current whenever the output current exceeds this value.

To accommodate special operation requirements, the screwdriver adjustment, called "CURRENT LIMIT ADJUST", is available on the Control Unit. The current limit can be thus manually set at any value in the range from 0 to 120% of the rated current supply.

NOTE: Current limiting adjustments available on this model are specified in Section A under "Protective Features".

FOR EXAMPLE: If it is desired to limit the output current to a maximum of 0.2 ampere, the procedure is as follows:

(1) Load the supply to at least 0.25 ampere.

NOTE: As the current limit is approached the supply regulation becomes slightly poorer. Consequently, for best regulation throughout the operating load current range, the current limit adjust should be set 25% higher than the maximum desired

output current.

(2) Turn the CURRENT LIMIT ADJUST control counter-clockwise until the output current reduces to 0.2 ampere.

In the above example the load regulation of the power supply will be within specification from 0 to 0.16 ampere.

.....MAXIMUM CURRENT ADJUST: (Designated MC on schematics)

Like the CURRENT LIMIT ADJUST, this limiter is part of the Comparison Amplifier circuitry in the Control Unit. The potentiometer associated with this control serves to establish a maximum safe current limit for the power supply. It is PRE-SET at the factory at a value equal to 120% of the maximum rated output current. When the output current tends to exceed this pre-set limit, the Pass Transistor biasing is automatically adjusted to reduce the pass current.

THE MAXIMUM CURRENT ADJUST SETTING SHOULD NOT BE CHANGED UNLESS IT IS REQUIRED FOR REMOTE ERROR SENSING OPERATION. (SEE IMMEDIATELY BELOW.)

.....MAXIMUM CURRENT ADJUSTMENT FOR OPERATION WITH REMOTE ERROR SENSING:

Unless the current limiters are adjusted for operation with remote error sensing the current supplied to the load will be limited to a value less than 120% of rated supply by the amount of voltage drop in the lead connections.

To avoid this limiting action, the following steps should be taken:

(1) Load the supply with a remotely connected resistor which will draw slightly more than 120% of the rated supply current at the indicated supply voltage.

(2) Turn the CURRENT LIMIT ADJUST to its maximum clockwise position.

(3) Turn the MAXIMUM CURRENT ADJUST clockwise until the output current is exactly 120% of the rated supply current.

(4) Turn the CURRENT LIMIT ADJUST counter-clockwise to limit the output current to any desired amount from 0 to 120% of maximum rated supply.

.....RP CONTROL ADJUSTMENT:

Some control units contain a locking type screwdriver adjustment designated "RP ADJUST". In converting to REMOTE OUTPUT VOLTAGE CONTROL OPERATION it may be necessary to adjust the ohms/volt ratio to the value specified in SECTION A under REMOTE OUTPUT VOLTAGE CONTROL. With the unit set up for remote output control, loosen the locking nut and turn the RP potentiometer under the proper ohms/volt between the remote voltage control resistance and the output voltage is obtained. (e.g. in a 1,000 ohms/volt unit a remote voltage control resistance of 18,000 ohms obtains an 18 volt output.)

Be sure to tighten the locking nut after this adjustment has been made.

PARTS LIST - MODEL SC-36-1
MODEL SC-36-1M*

DRAWING S-SC-36-1-02

B101	- Fan		
C101	- 1000	MF	80 WV
C102	- 1000	MF	80 WV
C103	- 0.1	MF	500 WV
C104	- Omitted		
C105	- 0.22	MF	200 WV
C106	- 0.1	MF	600 WV
C107	- 100	MF	150 WV
C108	- 100	MF	12 WV
C109	- 0.22	MF	200 WV
C110	- 0.22	MF	200 WV
C111	- 2	MF	200 WV
C201	- 10	MF	150 WV
C202	- 0.22	MF	200 WV
CR101 and CR102	- Silicon Rectifier TM-31		
CR103 and CR104	- Silicon Rectifier PT-5		
CR105	- Germanium Rectifier 1N91		
CR201 and CR202	- Silicon Rectifier PT-5		
F101	- 2 Amp. Fuse		
*M101	- Meter, 0-1 A DC		
*M102	- Meter, 0-50 V DC		
PL101	- Neon Pilot Light NE-51		
Q901 thru Q906	- Transistor 2N441-4		
R101	- 2.2	K	2 watt
R102	- Omitted		
R103	- 1	K	20 watt WW
R104	- 1	K	20 watt WW
R105	- 5.6	Ohm	1 watt
R106	- 500	Ohm	5 watt WW
R107	- 500	Ohm	5 watt WW
R108	- 3.9	K	2 watt
R109	- 40	K	2 watt Pot.
R110	- Omitted		

PARTS LIST - MODEL SC-36-1
MODEL SC-36-1M*

DRAWING S-SC-36-1-02

R111	- 180	Ohm	1 watt
R112	- 1	K	5 watt WW
R113	- 0.5	Ohm	3 watt WW
R201	- 330	K	1/2 watt
R202	- 1	K	5 watt
R901 thru R904	- 1.5	Ohm	3 watt WW

RL201 - 3PDT Relay

S101 - SPST Switch
S102 - Thermoswitch N. C.

T101 - Kepco #100-1042

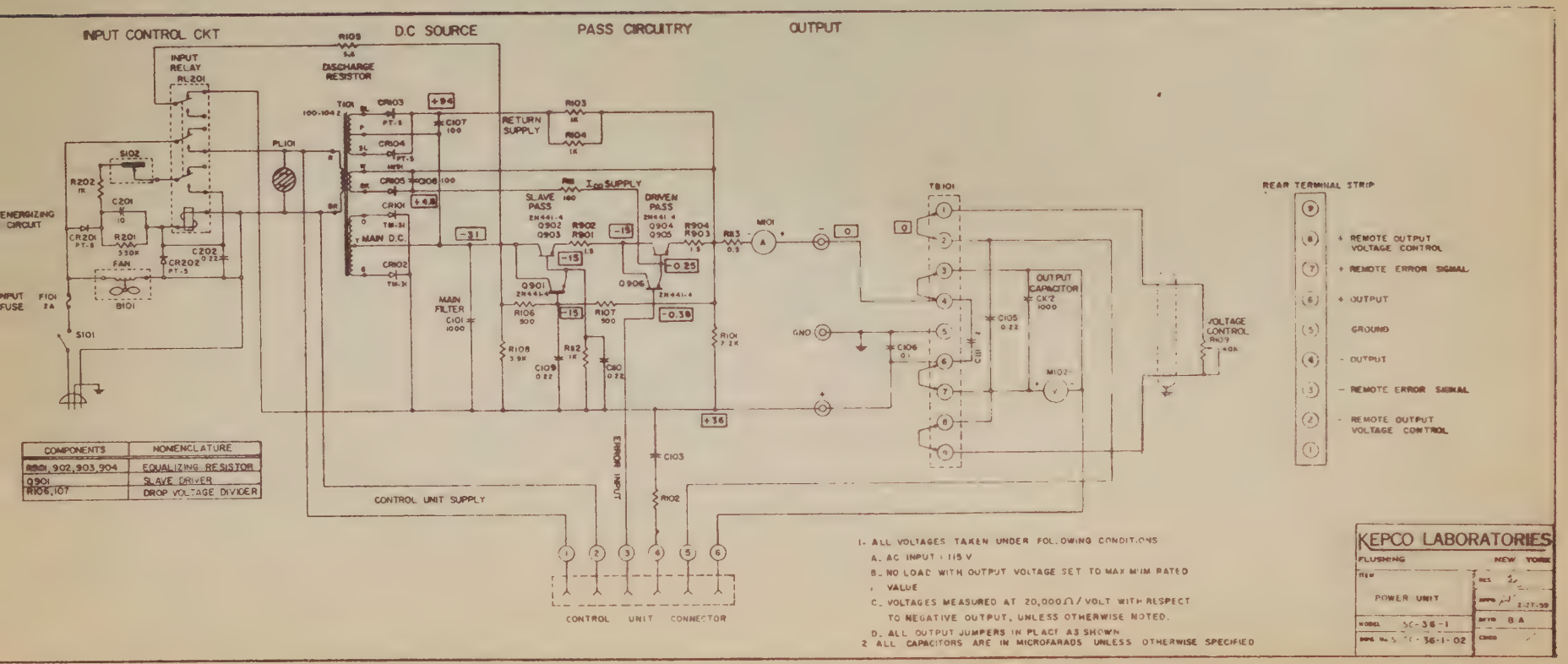
TB101 - Jones #9-140-Y

Schematic Number	Kepco Part Number	Description	Specifications	Mfr.	Mfr's Part No.
		Capacitors:			
C1	117-0156	Electrolytic, Pigtail	500 uf 12v +100, -10%	Industrial	21RM500
C2	117-0121	Electrolytic, Pigtail	100 uf 12v +100, -10%	Industrial	1B1091RM
C3	117-0122	Electrolytic, Pigtail	100 uf 50v +100, -10%	Industrial	05RM100
C4	117-0128	Mylar	0.4 uf 200v 10%	Hopkins	P42M
CR1-5	122-0007	Rectifier, Germanium, Pigtail Type		General Electric	1N91
Q1	119-0024	Transistor, NPN		Gen. Transistor	GT1092
Q2, 4	119-0022	Transistor, PNP		Tung-Sol	2N382
Q3	119-0007	Transistor, NPN		Gen. Transistor	2n35
		Resistors:			
R1	115-0872	Fixed, Molded	270 2w 5%	Allen-Bradley	HB2715
R2	115-0883	Fixed, Molded	390 1/2w 5%	Allen-Bradley	EB3915
R3	115-0884	Fixed, Molded	110 1/2w 5%	Allen-Bradley	EB1115
R4, 8, 9, 11	115-0467	Fixed, Molded	4.7k 1/2w 10%	Allen-Bradley	EB4721
R5	115-0334	Variable, Composition	5k 2 w 10%	Allen-Bradley	JA1L040S502UZ
R6	115-0489	Fixed, Molded	10k 1/2w 10%	Allen-Bradley	EB1031
R7	115-0581	Fixed, Molded	430 1/2w 5%	Allen-Bradley	EB4315
R10	115-0371	Fixed, Molded	220 1/2w 10%	Allen-Bradley	EB2211
R12	115-0563	Variable, Wire Wound	500 1.5w 20%	Wirt	WC-818A
R13	115-0558	Fixed, Molded	680 1/2w 10%	Allen-Bradley	EB3811

PARTS LIST - TRAM 2

CONTROL UNIT DRAWING S-TRAM-2-01

Schematic Number	Kepco Part Number	Description	Specifications			Mfr.	Mfr's Part No.
		Resistors:					
R14	115-0562	Variable, Wire Wound	2.5k	1.5w	20%	Wirt	WC-818A
R15	115-0560	Fixed, Molded	2.7k	1/2w	10%	Allen-Bradley	EB2721
R16	115-0554	Fixed, Molded	30	1/2w	5%	Allen-Bradley	EB3005
R17	115-0631	Fixed, Molded	220 ohm	1 w	10%	Allen-Bradley	GB2211
RD1	121-0012	Reference Diode				Hoffman	1N1773
RD2	121-0013	Reference Diode				Hoffman	RS-6
T1	100-1026	Transformer				Kepco	100-1026



COMPONENTS	NOMENCLATURE
R901, 902, 903, 904	EQUALIZING RESISTOR
Q901	SLAVE DRIVER
R106, 107	DROP VOLTAGE DIVIDER

1- ALL VOLTAGES TAKEN UNDER FOLLOWING CONDITIONS
A- AC INPUT = 115 V
B- NO LOAD WITH OUTPUT VOLTAGE SET TO MAXIMUM RATED VALUE
C- VOLTAGES MEASURED AT 20,000Ω / VOLT WITH RESPECT TO NEGATIVE OUTPUT, UNLESS OTHERWISE NOTED.
D- ALL OUTPUT JUMPERS IN PLACE AS SHOWN
2 ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED

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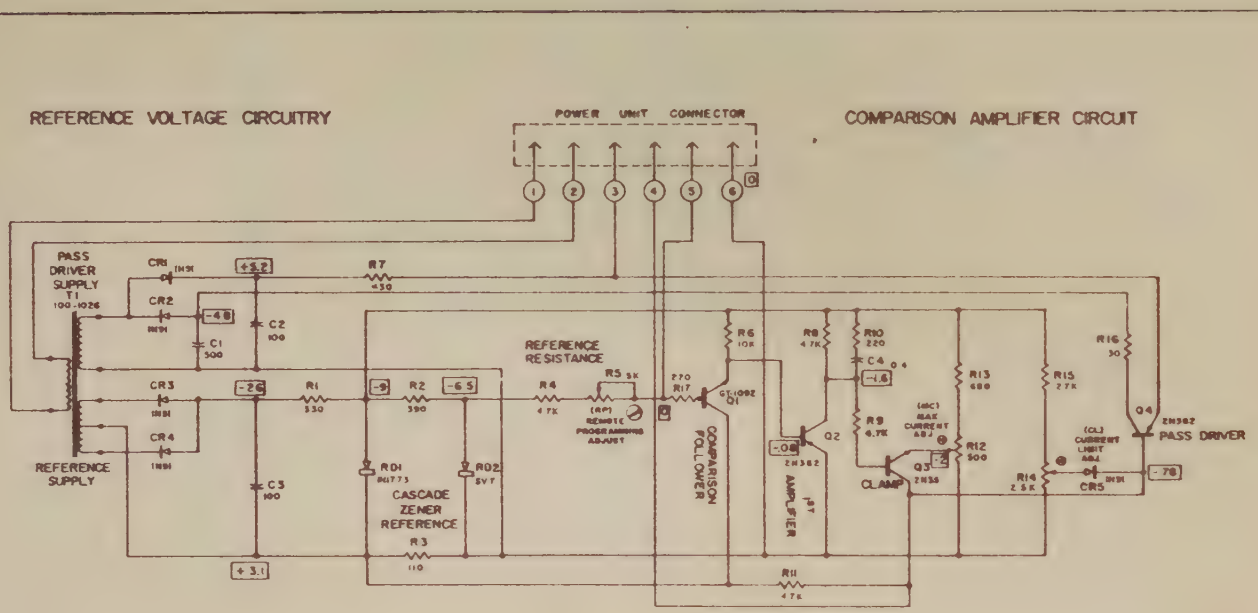
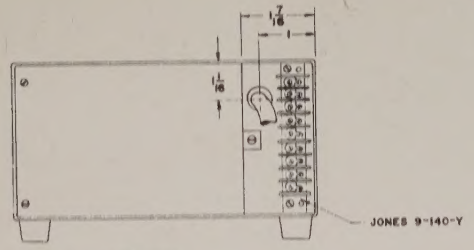
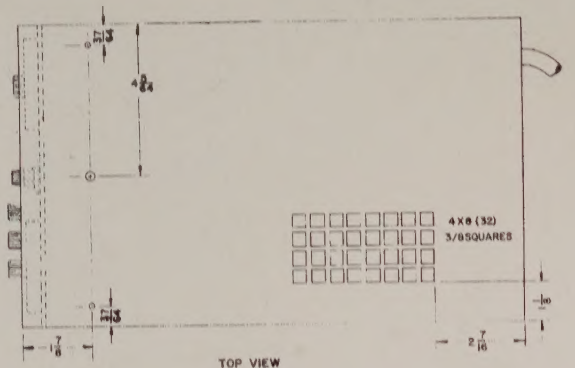
ITEM	POWER UNIT
MODEL	SC-36-1
DWG No.	SC-36-1-02
DES.	
APPD.	2-27-59
DRYD	B.A.
CHKD	

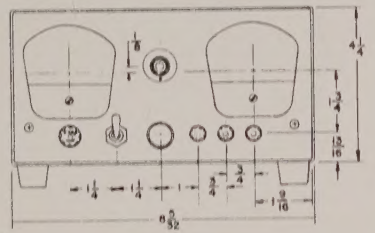

REFERENCE VOLTAGE CIRCUITRY
POWER UNIT CONNECTOR
COMPARISON AMPLIFIER CIRCUIT
PASS DRIVER SUPPLY T1 100-1026
REFERENCE SUPPLY
CR1 1N5I
CR2 1N5I
CR3 1N5I
CR4 1N5I
+5.2
-4.8
-2.6
+3.1
C1 500
C2 100
C3 100
R1 330
R2 390
R3 110
R4 47K
R5 5K
REFERENCE RESISTANCE
(RP) REMOTE PROGRAMMING ADJUST
CASCADE ZENER REFERENCE
RD1 IN1773
RD2 5V1
R6 10K
R7 430
R8 47K
R9 6.7K
R10 220
C4 0.4
R11 47K
R12 500
R13 680
R15 27K
R16 30
R17 270
Q1 GT-109Z
Q2 2N382
Q3 2N38
Q4 2N382
COMPARISON FOLLOWER
1ST AMPLIFIER
CLAMP
(MC) MAX CURRENT ADJ
(CL) CURRENT LIMIT ADJ
CR5 1N5I
PASS DRIVER
-7.8
-0.8
-2
-7.8
NOTE
1 ALL VOLTAGES TAKEN UNDER CONDITIONS SPECIFIED ON MAIN SCHEMATIC
2 ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED
KEPCO LABORATORIES
FLUSHING NEW YORK
CONTROL UNIT
TRAM-2
S-TRAM-2-01
B



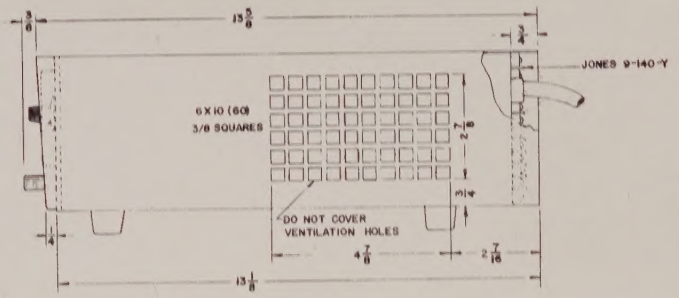
REAR VIEW



TOP VIEW



FRONT VIEW



RIGHT SIDE VIEW

NOTE
THIS DRAWING APPLIES TO THE FOLLOWING MODELS:
SC-18-0.5M
SC-18-1M
SC-18-2M
SC-36-0.5M
SC-36-1
SC-36-72-0.5M

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ITEM: OUTLINE DRAWING	DES.	CHKD.	
	APPD.	SCALE HALF	
	DFTM. W.P.	DATE 5-14-59	
MODEL SC-(SEE NOTE)	FINISH		REV. NO.
DWG. NO. 00-SC-36-1-01	KEPCO NO.		

Corrections of Model SC 36-1 Instruction Manual:

POWER UNIT:

1. Transistors identified by "Q" Nos. 101-106 in Parts Photos correspond to Q901-906 on Schematic Diagram.

2. Delete R102 from Power Unit Schematic and Parts Photos.

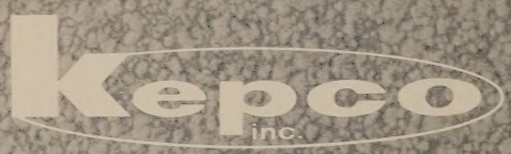
3. Change designation of R104 to R109 on Parts Photos.

CONTROL UNIT: (TRAM2)

1. RD-2 under the cover with Q1-Q3 on Control Unit (TRAM 2) Parts Photos.

2. R1 changed from 330 ohms to 270 ohms on Schematic Diagram.

3. RD2 changed from SV7 to RS6 on Schematic Diagram.



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